PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Form PCT/IPEA/416
P3037A		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI2004/000231	14.04.2004	15.04.2003

International Patent Classification (IPC) or national classification and IPC
B01J8/26, B01J8/38

Applicant
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1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 6 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
11.11.2004	12.09.2005

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Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

   Description, Pages

   1-21 as originally filed

   Claims, Numbers

   1-23 filed with telefax on 02.08.2005

   Drawings, Sheets

   1/5-5/5 as originally filed

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-23
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-23
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-23
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V.

1 INDEPENDENT CLAIMS 1 and 17

1.1 Document US-A1-5526775 (D1) is regarded as the closest prior art with regard to the subject-matter of claim 1 and discloses (the references in parenthesis applying to this document):

a fluidized bed reactor (10) comprising a furnace (14) having a bed of particulate material and a bottom provided with nozzles (16) for fluidizing gas (see figure 1), a heat exchange chamber (28) with heat exchanger surfaces (30) for recovering the heat from the particulate material and a discharge channel (38) for removing particulate material from the heat exchange chamber to the furnace.

The vertical section of the furnace (14) located between the bottom grid and the passage (50) represents a vertical auxiliary channel for transferring particulate material from the heat exchange chamber to the furnace (through the passage 50 in its overflow mode, see column 7, lines 39-45) and from the furnace to the heat exchange chamber (via passage 50, in its feed mode, see column 7, lines 39-42). This channel is provided with nozzles (16) for fluidizing gas. It is de facto connected with the bottom of the furnace its lower section, and includes in its upper part a flow conduit (50) for its connection with the heat exchange chamber.

1.2 The subject-matter of claim 1 differs from the disclosure of D1 in that the nozzles of the auxiliary channel are adjustable independently from the other fluidizing nozzles of the reactor.

1.3 The subject-matter of claim 1 is therefore new in the sense of Article 33 (2) PCT.

1.4 The problem to be solved by the present invention may therefore be regarded as to control the direction and the flow rate of the bed material recirculation rate within the auxiliary channel independently from the rest of the operation of the reactor.

1.5 Since no document available in the prior art discloses the use of the features described in the paragraph 1.2 here above in order to solve the problem mentioned in the paragraph 1.4 here above, the subject-matter of claim 1 also involves an inventive step in the sense

of Article 33(3) PCT.

1.6 The same reasoning also applies to independent claim 17.

2. DEPENDENT CLAIMS

Claims 2-16,18-23 are dependent on claims 1 or 17 and can therefore also be considered as new and inventive.

Claims

1. A fluidized bed reactor (10), comprising:
- a furnace (16), having a bed of particulate material and a bottom (24) provided with nozzles (26) for fluidizing gas, said bottom limiting the furnace from the bottom;
- a heat exchange chamber (40) provided with heat exchange surfaces (48) for recovering heat from the particulate material; and
- a discharge channel (52) connected to the lower part of the heat exchange chamber for removing particulate material from the heat exchange chamber (40) to the furnace (16);
characterized in that
the fluidized bed reactor (10) comprises a substantially vertical auxiliary channel (62) for transferring particulate material from the heat exchange chamber (40) to the furnace (16) and from the furnace (16) to the heat exchange chamber (40), the lower part of the auxiliary channel (62) being provided with nozzles (68) for fluidizing gas that are adjustable independently from the other fluidizing nozzles of the reactor and with a flow conduit (64) for connecting the auxiliary channel to the furnace (16), and the upper part of the auxiliary channel (62) being provided with a flow conduit (66) for connecting the auxiliary channel (62) to the heat exchange chamber (40).

2. Fluidized bed reactor in accordance with claim 1, **characterized** in that the discharge channel (52) is substantially vertical, the lower part of the discharge channel is provided with nozzles for fluidizing gas (58) and the lower part of the discharge channel is provided with a flow conduit (50) for connecting the heat exchange chamber (40) to the discharge channel (52) and the upper part with a flow conduit (60) for connecting the discharge channel (52) to the furnace (16).

3. Fluidized bed reactor in accordance with claim 2, **characterized** in that the furnace (16), the heat exchange chamber (40), the discharge channel (52) and the auxiliary channel (62) form an integrated structure, having the discharge channel (52) and the auxiliary channel (62) adjacently arranged between the furnace (16) and the heat exchange chamber (40).

4. Fluidized bed reactor in accordance with claim 2, **characterized** in that the reactor (10) comprises two discharge channels (52), and the auxiliary channel (62) is arranged between the two discharge channels.

5. Fluidized bed reactor in accordance with claim 2, **characterized** in that the discharge channel (52) and the auxiliary channel (62) are at least partially at the same height level.

6. Fluidized bed reactor in accordance with claim 5, **characterized** in that the flow conduit (66) in the upper part of the auxiliary channel (62) is at most at an about 500 mm higher height level than the flow conduit (60) in the upper part of the discharge channel (52).

7. Fluidized bed reactor in accordance with claim 6, **characterized** in that the flow conduit (66) in the upper part of the auxiliary channel (62) is at most at an about 300 mm higher height level than the flow conduit (60) in the upper part of the discharge channel (52).

8. Fluidized bed reactor in accordance with claim 2, **characterized** in that the flow conduit (64) in the lower part of the auxiliary channel (62) is at a higher height level than the flow conduit (50) in the lower part of the discharge channel (52).

9. Fluidized bed reactor in accordance with claim 1,

characterized in that the flow conduit (64) in the lower part of the auxiliary channel (62) is at an at least 200 mm higher height level than the bottom (24) of the furnace.

10. Fluidized bed reactor in accordance with claim 1, **characterized** in that the lower part of the auxiliary channel (62) is at the level of the bottom (24) of the furnace and the flow conduit (64) in the lower part of the auxiliary channel comprises nozzles (86) for fluidizing gas, which nozzles direct fluidizing gas towards the furnace (16).

11. Fluidized bed reactor in accordance with claim 1, **characterized** in that the flow conduit (64) in the lower part of the auxiliary channel (62) is provided with step grid nozzles (86).

12. Fluidized bed reactor in accordance with claim 1, **characterized** in that nozzles for fluidizing gas are arranged at different height levels of the auxiliary channel (62).

13. Fluidized bed reactor in accordance with claim 1, **characterized** in that the reactor comprises means (70) for measuring the temperature of the furnace (16), heat exchange chamber (40) or the discharge channel (52) or of the particulate material in one of them or of the heat exchange medium flown through the heat exchange surfaces (48) arranged in the heat exchange chamber, and means for adjusting the flow velocity of the fluidizing gas to be fed to the lower part of the auxiliary channel (62) based on the measured temperature.

14. Fluidized bed reactor in accordance with claim 1, **characterized** in that the heat exchange chamber (40) comprises first means (72, 30, 36) for feeding

particulate material from the fluidized bed reactor to the heat exchange chamber (40).

15. Fluidized bed reactor in accordance with claim 14, **characterized** in that the furnace (16) and the heat exchange chamber (40) have a common wall part (14a) and the first means for feeding particulate material to the heat exchange chamber (40) comprise at least one opening (72) in the common wall part (14a).

16. Fluidized bed reactor in accordance with claim 14, **characterized** in that the fluidized bed reactor (10) is a circulating fluidized bed reactor, the upper part of which furnace is provided with a discharge opening (28) for the discharge of exhaust gases and particulates entrained therewith from the furnace (16), and the first means for feeding particulate material to the heat exchange chamber (40) comprise a separator (30) for separating particles from the exhaust gases of the furnace, and a return duct (36) for guiding at least a portion of the separated particels to the heat exchange chamber (40).

17. A method of recovering heat in a fluidized bed reactor (10), said method comprising the steps of:

(a) feeding carbonaceous fuel (18) and oxygenous fluidizing gas (20) to a furnace of the reactor;

(b) feeding hot bed material particles from the furnace (16) to the upper part of a heat exchange chamber (40);

(c) recovering heat from the hot bed material particles in the heat exchange chamber (40), whereby cooled bed material particles are produced;

(d) discharging cooled bed material particles from the lower part of the heat exchange chamber (40);

characterized in that the method comprises a step of:

(e) discharging hot bed material particles in a first

operational state of the fluidized bed reactor (10) as an overflow from the upper part of the heat exchange chamber to the furnace downwards along a substantially vertical auxiliary channel (62) and transferring in a second operational state of the fluidized bed reactor (10) hot bed material particles from the furnace (16) to the heat exchange chamber (40) upwards along the substantially vertical auxiliary channel (62) by means of fluidizing gas fed to the lower part of the auxiliary channel (62) through nozzles (68) within the auxiliary channel that are adjustable independently from the other fluidizing nozzles of the reactor.

18. Method in accordance with claim 17, **characterized** in that the amount of hot bed material transferred from the furnace (16) to the heat exchange chamber is adjusted by altering the amount of the fluidizing gas fed to the lower part of the auxiliary channel (62).

19. Method in accordance with claim 18, **characterized** in that the method comprises a step of:

(f) measuring the temperature of the furnace (16), the heat exchange chamber (40) or the discharge channel (52) or the material in one of them or the temperature of heat exchange medium flown through heat exchange surfaces (48) arranged in the heat exchange chamber, and adjusting the amount of fluidizing gas fed to the lower part of the auxiliary channel in step (e) based on the temperature measured in step (f).

20. Method in accordance with claim 17, **characterized** in that at high loads of the fluidized bed reactor, hot bed material particles are discharged as an overflow from the upper part of the heat exchange chamber (40) downwards along the substantially vertical auxiliary channel (62)

and at low loads of the fluidized bed reactor hot bed material particles are transferred by means of fluidizing gas fed to the lower part of the auxiliary channel (62) from the furnace (16) to the heat exchange chamber upwards along the substantially vertical auxiliary channel (62).

21. Method in accordance with claim 17, **characterized** in that the fluidized bed reactor (10) is a circulating fluidized bed reactor and step (b) is carried out by feeding particles separated by a separator (30) of the hot circulation of the circulating fluidized bed reactor to the heat echange chamber (40).

22. Method in accordance with claim 17, **characterized** in that step (b) takes place by feeding particulate material directly from the furnace (16) to the heat exchange chamber (40) through an opening (72) in the common wall part (14a) thereof.

23. Method in accordance with claim 17, **characterized** in that in the second operational state in step (e) fluidizing gas is fed to the auxiliary channel (62) at more than one height level.